

CLAIMS

- 1 1. A cell-balancing circuit for a battery pack having a plurality of series-arranged
2 cells comprising:
3 a bridge connected around a first cell, including a bypass resistor in series with a
4 switch; and
5 a cell monitor/regulator having an input connected across the first cell for meas-
6 uring a charge of the first cell, wherein the cell monitor/regulator closes the switch when
7 a charge of the first cell equals a maximum value.
- 1 2. The circuit as set forth in claim 1 wherein the cell monitor/regulator includes a
2 comparator that compares a relative voltage potential across the first cell with respect to a
3 reference voltage potential.
- 1 3. The circuit as set forth in claim 2 wherein the cell monitor/regulator includes a
2 voltage divider connected across the first cell and having an output connected to a first
3 input of the comparator, and a reference voltage source that outputs the voltage potential
4 to a second input of the comparator.
- 1 4. The circuit as set forth in claim 3 wherein an output of the comparator is con-
2 nected to a lead of the switch, the switch being constructed and arranged so that the
3 switch closes when the comparator measures a voltage at the second input greater than a
4 voltage at the first input.
- 1 5. The circuit as set forth in claim 4 wherein the switch comprises a transistor that is
2 variably saturated in response to an output of the comparator.
- 1 6. The circuit as set forth in claim 1 further comprising battery pack terminals lo-
2 cated at respective opposing ends of the series-arranged cells, and a charging circuit, the
3 terminals being connected to respective opposing leads of a charging circuit so as to
4 charge the cells.

1 7. The circuit a set forth in claim 6 wherein the charging circuit includes a sense re-
2 sistor located in line with one of the terminals, a voltage sensor that measures an overall
3 voltage across the sense resistor and a regulator that determines a maximum current de-
4 livered to the battery pack by the charging circuit in response to a measured value the
5 overall voltage.

1 8. The circuit as set forth in claim 7 wherein the charging circuit and the battery
2 pack each receive current from a transcutaneous energy transmission (TET) module im-
3 planted in a body and the battery pack is adapted to be implanted in the body.

1 9. The circuit as set forth in claim 8 wherein the battery pack is operatively con-
2 nected to a life-saving system implanted in the body.

1 10. The circuit as set forth in claim 9 wherein the life-saving system includes a heart
2 treatment device.

1 11. The circuit as set forth in claim 1 wherein the cells comprise lithium ion-type
2 cells.

1 12. The circuit as set forth in claim 1 wherein each of the cells includes a respective a
2 bridge connected around each of the cells, including a bypass resistor in series with a
3 switch, and a cell monitor/regulator having an input connected across each of the cells for
4 measuring a charge thereof, wherein the cell monitor/regulator closes the switch when a
5 charge of each of the cells respectively equals a maximum value.

1 13. The circuit as set forth in claim 12 wherein the cells comprise at least six cells.

1 14. The circuit as set forth in claim 13 wherein the cells comprise lithium ion-type
2 cells.

- 1 15. A method for balancing charge levels of cells in a multiple-cell battery pack hav-
2 ing a plurality of the cells arranged in a series comprising:
3 bridging around a first cell with a bypass resistor and a switch;
4 monitoring a charge level of one of the cells based upon an input connected across
5 the first cell; and
6 closing the switch when the charge level of the first cell equals a maximum value
7 so as to shunt charge current around the cell through the bypass resistor.
- 1 16. The method as set forth in claim 15 wherein the step of monitoring includes com-
2 paring a relative voltage potential across the first cell with respect to a reference voltage
3 potential.
- 1 17. The method as set forth in claim 16 wherein the step of comparing includes pro-
2 viding cell monitor/regulator includes a voltage divider connected across the first cell and
3 having an output connected to a first input of the comparator, and a reference voltage
4 source that outputs the voltage potential to a second input of the comparator.
- 1 18. The method as set forth in claim 17 further comprising connecting an output of
2 the comparator to a lead of the switch, the switch closing a path through the bridge when
3 the comparator measures a voltage at the second input greater than a voltage at the first
4 input.
- 1 19. The method as set forth in claim 18 further comprising saturating a transistor in
2 response to an output of the comparator when the comparator measures a voltage at the
3 second input greater than a voltage at the first input.
- 1 20. The method as set forth in claim 15 further comprising locating battery pack ter-
2 minals at respective opposing ends of the series of the plurality of the cells, and connect-
3 ing respective opposing leads of a charging circuit to the terminals at predetermined
4 times so as to charge the plurality of cells.

1 21. The method a set forth in claim 20 further comprising connecting a sense resistor
2 in line with one of the terminals, and measuring an overall voltage across the sense re-
3 sistor and regulating a maximum current delivered to the battery pack by the charging
4 circuit in response to a measured value the overall voltage.

1 22. The method as set forth in claim 15 wherein the cells comprise lithium ion-type
2 cells.

1 23. The method as set forth in claim 15 further comprising monitoring each of the
2 cells based upon an input connected across each of the cells for measuring a charge of the
3 each of the cells respectively, and providing a bridge around the each of the cells, the
4 bridge including a respective bypass resistor and a respective switch and closing the re-
5 spective switch when the charge of the each of the cells equals a maximum value so as to
6 shunt charge current around the each of the cells through the respective bypass resistor.

1 24. The method as set forth in claim 20 wherein the cells comprise at least six cells.

1 25. The method as set forth in claim 24 wherein the cells comprise lithium ion type
2 cells.

1 26. The method as set forth in claim 15 further comprising operatively connecting the
2 cells to a life-saving system and powering the life-saving system with the cells.

1 27. The method as set forth in claim 26 further comprising implanting the cells in a
2 body and providing an external power source that transmits charging current to the cells.

1 28. The method as set forth in claim 27 wherein the step of providing the external
2 power source includes transmitting energy through a skin layer of the body using induc-
3 tion.

1 29. A multiple-cell rechargeable battery pack comprising:

2 a plurality of cells, each of the cells being interconnected in a series line between
3 a pair of opposing battery pack-end terminals adapted to receive a charge current on the
4 series line;

5 a respective cell monitor/regulator connected across each of the cells for measur-
6 ing a charge of the each of the cells; and

7 a respective shunt bridge connected across each of the cells including a switch
8 that selectively closes the shunt bridge to direct the charge current around the cell through
9 the series line in response to a measurement of the charge of each of the cells by the
10 monitor/regulator .

1 30. The battery pack as set forth in claim 29 wherein the cell monitor/regulator in-
2 cludes a comparator that operates the switch to close when the charge respectively ex-
3 ceeds a predetermined reference value.

1 31. The battery pack as set forth in claim 30 further comprising a casing for enclosing
2 the cells that is sealed and comprises a biocompatible material adapted for implantation
3 in a body.

1 32. The battery pack as set forth in claim 31 wherein the cells are connected to, and
2 receive the charging current from, a transcutaneous energy transmission (TET) system
3 adapted for implantation in a body so as to receive energy through a skin layer of the
4 body by induction.

1 33. A transcutaneous energy transmission (TET) system adapted for implantation in a
2 body and for powering an implanted life-saving device comprising:

3 an implanted TET module for receiving energy through the skin and transmitting
4 electricity derived from the energy to a life-saving device; and

5 an implanted rechargeable battery pack including a battery pack having a plurality
6 of series-arranged cells, having a bridge connected around a first cell, including a bypass
7 resistor in series with a switch, and a cell monitor/regulator having an input connected

8 across the first cell for measuring a charge of the first cell, wherein the cell moni-
9 tor/regulator closes the switch when a charge of the first cell equals a maximum value.

1 34. The TET system as set forth in claim 33 wherein the battery pack is
2 adapted to be charged when the implanted TET module receives energy from an external
3 TET transmitter and to discharge, so as to power the life-saving device when the im-
4 planted TET module receives one of either no energy or insufficient energy.